

A method is provided for scaling up permeabilities associated with a fine-scale grid of cells representative of a porous medium to permeabilities associated with an unstructured coarse-scale grid of cells representative of the porous medium. An areally unstructured, Voronoi, computational grid is generated using the coarse-scale grid as the genesis of the computational grid. The computational grid is then populated with permeabilities associated with the fine-scale grid. Flow equations are developed for the computational grid, the flow equations are solved, and inter-node fluxes and pressure gradients are then computed for the computational grid. These inter-node fluxes and pressure gradients are used to calculate inter-node average fluxes and average pressure gradients associated with the coarse-scale grid. The inter-node average fluxes and average pressure gradients associated with the coarse grid are then used to calculate upscaled permeabilities associated with the coarse-scale grid.